2014

Differential Survival of Chaparral Shrub Species in Response to Severe Drought

Hannah Dario
Pepperdine University

Differential Survival of Chaparral Shrub Species in Response to Severe Drought

Hannah Dario

Mentor: Dr. Stephen D. Davis

Pepperdine University, 24255 Pacific Coast Highway, Malibu, CA 90263

Abstract

In this experiment, we examined how the plants in the Santa Monica Mountains are responding to the driest period in recorded history for California. Our hypothesis was that plant species with the deepest roots would have highest survivorship. We thought this because deep-rooted shrubs will have greater access to soil moisture. This hypothesis was tested by collecting data on plant survival, in a mixed chaparral stand, containing eleven species, growing in the Green Valley Preserve off of Stunt road, in the Santa Monica Mountains. The chaparral stand was 21 years old, having last burned in 1993 (Old Topanga Canyon Fire). In the end, we discovered that our hypothesis was supported. Our data indicated that deep-rooted species had significantly higher survivorship during severe drought than shallow rooted species.

Introduction

An increasing problem around the world is drought. This has recently become evident in the Santa Monica Mountains of southern California. In this Mediterranean-type climate, there are consistent summer rainless periods, with periodic extended droughts over several years. These dry conditions cause the chaparral vegetation to become less hydrated. Since chaparral shrubs are evergreen, they must continually supply water to their leaves throughout the year, in order to survive. But severe dehydration during drought can block water supplies to leaves through xylem cavitation and embolism formation (Davis et al. 2002, Pratt et al. 2007). Cavitation is when the water in a plant's plumbing system (vessels or tracheid) physically separates and air is drawn in that fills the space previously occupied by water. This air forms a gas bubble, known as an air embolism, or blockage to water flow to evergreen leaves (Davis et al. 2002).

These last three years in southern California have been the warmest, driest and longest drought on record. We was interested in determining how plants will respond to such extreme conditions since they have never encountered such a desiccating environment.

Through an investigation of the relationship between survivorship and rooting depth of shrubs, we hoped to better understand the impact of our current drought on plant community structure and predict future events driven by climate change.

Methods

Figure 1. A "Point-Quarter Sampling Technique" (Cox, 1985) was used to determine the percent mortality of adult species of chaparral shrubs at the Green Valley Preserve off of Stunt road, in the Santa Monica Mountians.

Study Site

Figure 2. View of our study site at the Green Valley Preserve, in the Santa Monica Mountains. Note significant browning of species and evidence of severe canopy dieback. Typical chaparral forms a closed canopy with little light reaching the soil surface, which is not the case in this photograph.

Results

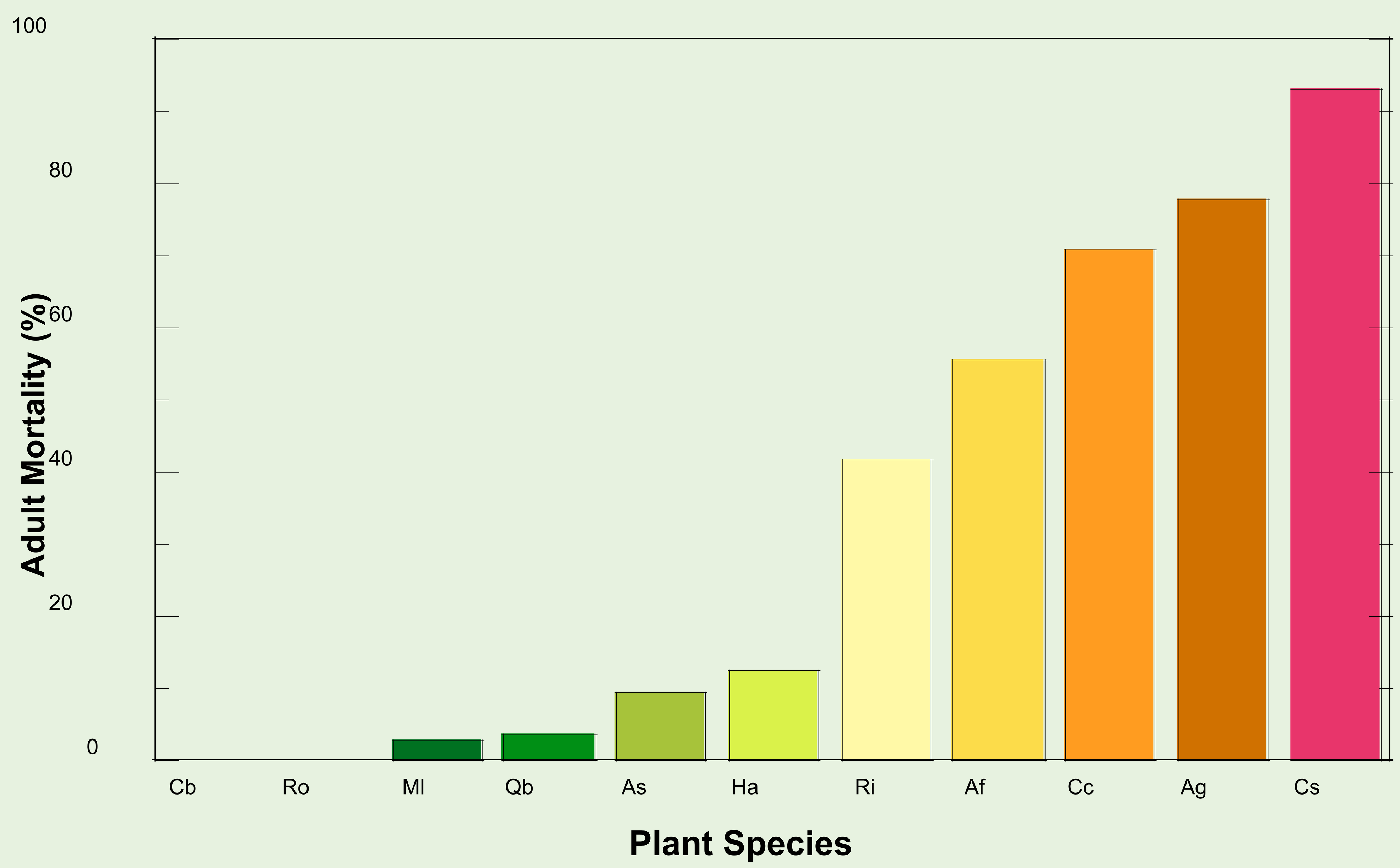

Figure 3: This figure represents all eleven species in our mixed chaparral stand. Note that highest mortality among shrub species occurred in shallow rooted shrubs (Af = *Adenostoma fasciculatum*, Cc = *Ceanothus cuneatus*, Ag = *Arctostaphylos glauca*, Cs = *Ceanothus spinosus*). These same species have relatively shallow roots and Cc and Ag are non-sprouters after fire. This means, that adults are only as old as the last fire, thus roots have only had 21 years to reach their maximum depth. In contrast, Ml, Qb, As, Ha, Ro, and Cb are vigorous sprouters after fire, their roots are likely much older than 21 years, and they are known to have relatively deep roots compared to non-sprouters after fire (Cc and Ag). Ri is intermediate in these traits.

Discussion

The above graph shows the adult mortality rate of each plant species found in the study site. The plants on the left side (from Cb = *Cercocarpus betuloides* to Ha = *Heteromeles arbutifolia*) are deep rooted. The plants on the right side (Ri = *Rhamnus ilicifolia* to Cs = *Ceanothus spinosus*) are shallow rooted.

Conclusion

Overall, we conclude that our hypothesis is supported by the data: the deep rooted plants show significantly lower mortality rates than the shallow rooted plants. As a result, we predict that the vegetation at this site will likely shift in species composition towards deeply rooted species under conditions of severe drought and continued climate change.

References

Cox, G.W. 1985. *Laboratory manual of general ecology*. Wm. C. Brown Company Pub., 248p

Davis, S.D., F.W. Ewers, J.S. Sperry, K.A. Portwood, M.C. Crocker, and G.C. Adams 2002.

Pratt, R.B., A.L. Jacobsen, K. Golgotiu, J.S. Sperry, F.W. Ewers, S.D. Davis. 2007. Life history type and water stress tolerance in nine California chaparral species (Rhamnaceae). Ecological Monographs. 77:239-253.

Special Thanks

I would like to give a special thanks to Dr. Martin Venturas, Keb Doak, Allison Hubbard and Alawna Jamison for helping conduct this collaborative research. I would also like to especially thank Dr. Davis for guiding me, helping me throughout this experiment, and for giving me professional insight on this specific subject. Also, many thanks to the WM Keck Foundation for funding this research and the Mountains Restoration Trust for their logistic support.